MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2015/2016

TCV3151 – COMPUTER VISION

(All sections / Groups)

10 October 2015
9.00 am – 11.00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 8 pages with 6 questions only.
2. Attempt **FIVE** out of **SIX** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the answer booklet provided.

QUESTION 1

(a) Consider a computer vision problem to inspect printed circuit boards (PCB). The circuit boards come to the boxing area on a conveyer belt, and they will be scanned for both catastrophic failure (e.g. missing component) and quality defects (e.g. fillet size or shape or component skew).

(i) Describe the sensor that can be used for this problem. [1 mark]

(ii) Explain the pre-processing and segmentation processes involved. [2 marks]

(iii) Outline an appropriate method that can be used to represent/describe the PCB components in this problem. [2 marks]

(b) Describe the THREE basic signal types. Provide an example for each signal type. [3 marks]

(c) Suppose an observer is looking at Menara Taming Sari, a 110 meter revolving gyro tower in Malacca City. What is the size of the retinal image that will be reflected in the area of the observer's fovea given that the observer is standing 300 meter away from the tower? The distance between the focal center of the lens and the retina is approximately 14 millimetre.

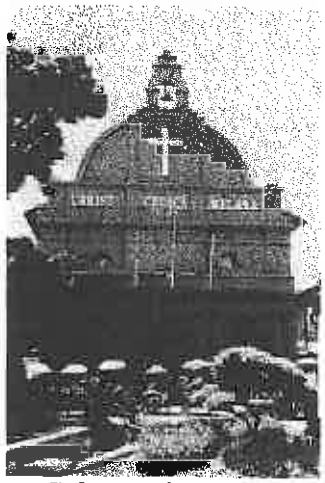
[2 marks]

Continued .....

QUESTION 2

(a) Suppose you are working on some digital images of historical buildings in Malacca to be uploaded to a website. Due to bandwidth limitation, you subsample the images into half of their original sizes. Following is the effect you observe after sub-sampling an image.

Original image

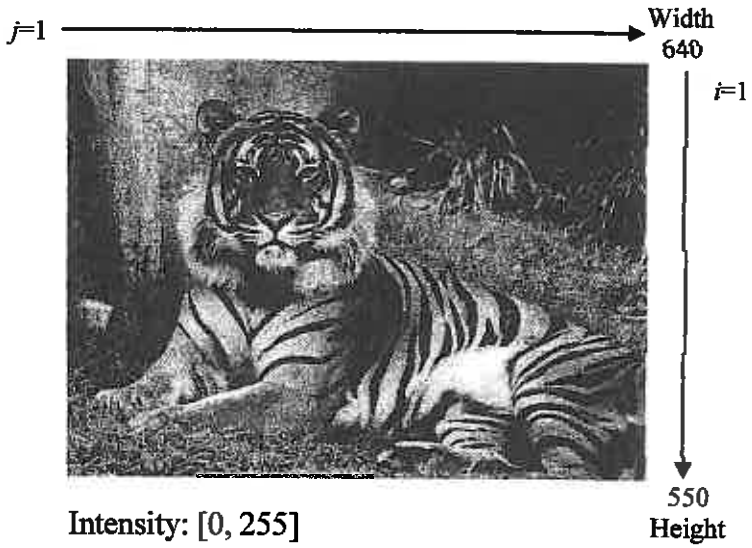


Sub-sampled image

(i) What effect do you observe in the subsampled image? What causes this effect to happen? [2 marks]

(ii) How can this effect be remedied? [2 marks]

(b) Consider a digitized image of a Malayan tiger. Calculate the number of bits that are required to store the image. [2 marks]



Intensity: [0, 255]

Continued .....

(c) Answer the following questions based on connectivity and explain your answers.

(i) True or False: Figure 2a contains patterns that are 4-connected. [1 mark]

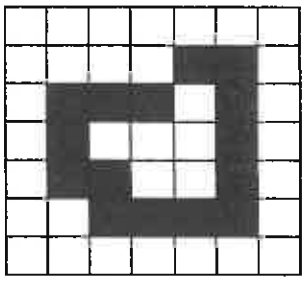


Figure 2a

(ii) True or False: Figure 2b contains patterns that are 8-connected but not 4-connected. [1 mark]

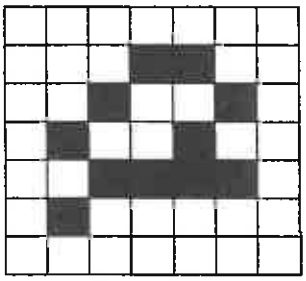


Figure 2b

(iii) Modify Figure 2b by changing at most 2 pixels so that the pattern is not 8-connected. [2 marks]

Continued .....

QUESTION 3

(a) Why do you think noise reduction can be achieved using a low-pass filter in digital image processing? Give an example of a low-pass filter and draw a sketch for this filter. You can use a 3 × 3 filter. [2 marks]

(b) Figure 3.1 shows a 3-bit image of size 5 × 5 in the square, with x and y coordinates specified.

y \ x	1	2	3	4	5
1	0	6	5	2	1
2	1	5	6	4	3
3	2	6	7	6	5
4	1	1	3	2	7
5	5	4	5	7	1

Figure 3.1

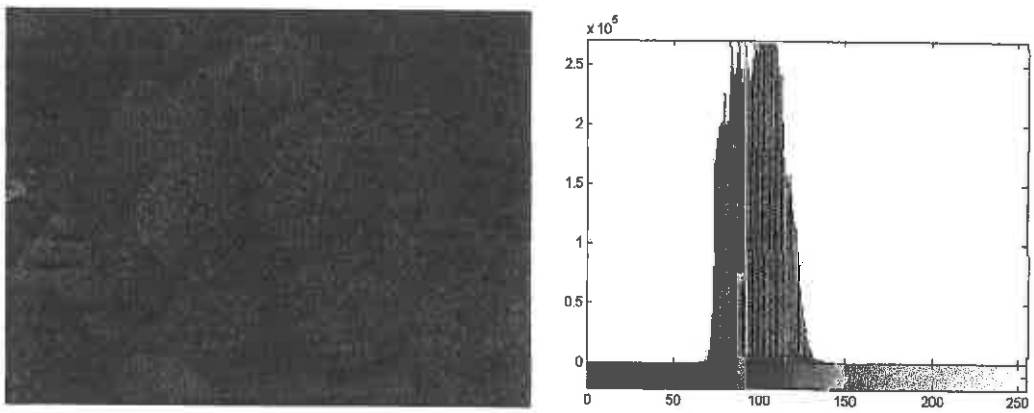
(i) Compute the output of a 3 × 3 median filter at (3, 3). [1 mark]

(ii) Compute the output of a 3 × 3 Laplacian filter at (3, 3). A Laplacian filter is given by [0 1 0; 1 -4 1; 0 1 0]. [2 marks]

(c) Apply histogram equalization on Figure 3.1 and show the output of the image. Assume the grayscale values range from 0 to 9.

[3 marks]

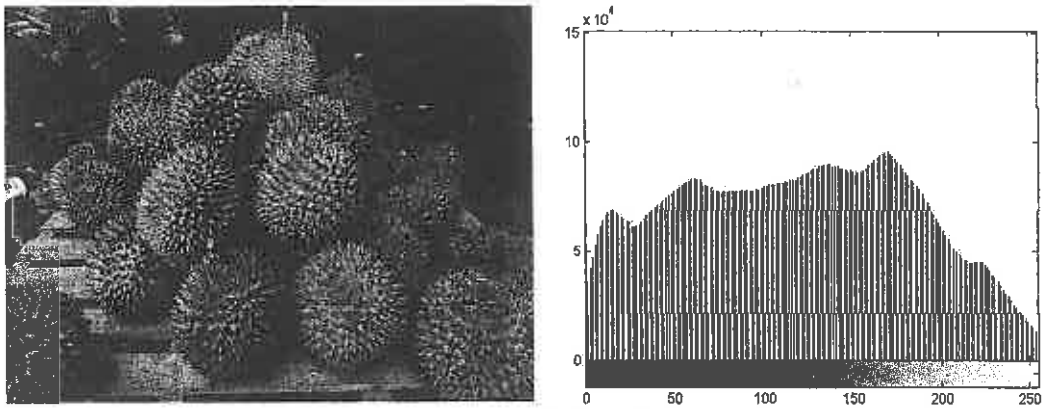
(d) Given the following image with its intensity histogram.



Original image with its intensity histogram.

Continued .....

An improved version of the original image, together with its intensity histogram is shown below. Which operation do you think is applied to improve the original image? Provide justification to your answer.



Improved image with its intensity histogram.

[2 marks]

Continued .....

QUESTION 4

(a) Fill in the blanks with the correct answers.

(i) _____ highlights a specific range of gray levels in an image.
(ii) _____ is very effective when the noise pattern consists of strong, spikelike components and the characteristic to be preserved is edge sharpness.
(iii) Approaches in the _____ are based on direct manipulation of pixels in an image.
(iv) _____ filter removes selected frequency regions between low and high frequencies.
(v) _____ is often used to degrade images for the evaluation of image restoration algorithms.

[5 marks]

(b) Suppose you are developing an automated system to recognize words from scanned documents. Given a scanned document depicted in Figure 4.1. You apply thresholding to segment the words from the background image. Nevertheless, you get an undesired result as shown in Figure 4.2.

Figure 4.1

Figure 4.2

(i) Why do you think thresholding does not work for this scenario? [2 marks]

(ii) What is a better way to segment the words from the background image? Describe the method. [3 marks]

Continued .....

QUESTION 5

(a) Figure 5.1 shows the side view of Multimedia University Library. The output in Figure 5.2 to Figure 5.4 are observed when three different types of gradient masks are applied on the original image. Name the possible gradient masks that are applied on the image. Draw a 3×3 mask for each of them.

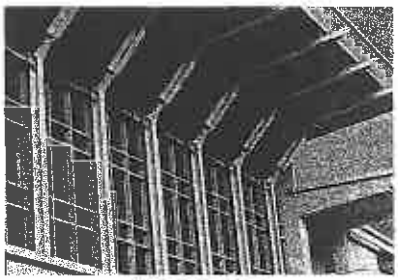


Figure 5.1

Figure 5.2

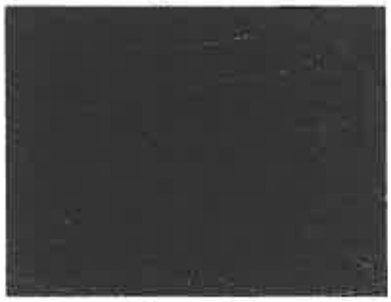


Figure 5.3

Figure 5.4

[3 marks]

(b) Consider the binary images shown in Figure 5.5 and Figure 5.6. The two images contain equal number of 0s and 1s.

1	1	1	0	0	0
1	1	1	0	0	0
1	1	1	0	0	0
1	1	1	0	0	0
1	1	1	0	0	0
1	1	1	0	0	0

Figure 5.5

1	0	1	0	1	0
0	1	0	1	0	1
1	0	1	0	1	0
0	1	0	1	0	1
1	0	1	0	1	0
0	1	0	1	0	1

Figure 5.6

(i) Construct the normalized co-occurrence matrices for Figure 5.5 and Figure 5.6 for displacement $d = [0,1]$. [2 marks]

Continued .....

(ii) Compute the following gray-level co-occurrence matrix (GLCM) for the two figures:
(a) Energy
(b) Homogeneity
(c) Contrast [3 marks]

(iii) Describe the nature of textures in Figure 5.5 and Figure 5.6 based on the GLCM features computed in (ii). [2 marks]

QUESTION 6

(a) Compare and contrast the approaches to object recognition: (1) Geometry-based, (2) Appearance-based, and (3) Feature-based. [3 marks]

(b) Scale-invariant feature transform (SIFT) has the ability to find distinctive keypoints in images. In your opinion, how can this technique be used for object recognition? [2 marks]

(c) The diagram below depicts the first and the last frame of a movie.

0	0	0	0	0	0	0	0
0	100	100	0	0	0	0	0
0	100	100	0	0	0	0	0
0	0	0	0	0	0	0	0

First frame

0	0	0	0	0	0	0	0
0	0	0	0	0	100	100	0
0	0	0	0	0	100	100	0
0	0	0	0	0	0	0	0

Last frame

There is a total of 5 frames, and in each frame the grey square moves one pixel to the right. Compute and write down the cumulative difference image of this sequence with $a_k = 0.1k$ for $k = 1, \ldots, 5$.

[5 marks]

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